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REVIEW ARTICLE

The Long-Term Effects of Bariatric Surgery on Type 2 Diabetes Remission, Microvascular and Macrovascular Complications, and Mortality: a Systematic Review and Meta-Analysis

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Abstract This systematic review aimed to evaluate the long-term (≥ 5 years) outcomes of bariatric surgery on diabetes remission, microvascular and macrovascular events, and mortality among type 2 diabetes (T2D) patients. Ten articles (one randomized controlled trial and nine cohorts) met the inclusion criteria and were included in this review. Pooled estimates of nine cohort studies showed that surgery significantly increased the diabetes remission (relative risk (RR) = 5.90; 95% CI 3.75–9.28), reduced the microvascular (RR = 0.37; 95% CI = 0.30–0.46) and macrovascular events (RR = 0.52; 95% CI 0.44–0.61), and mortality (RR = 0.21; 95% CI 0.20–0.21) as compared to non-surgical treatment. Available evidence suggests better remission and lower risks of microvascular and macrovascular disease and mortality in the surgery group as compared to non-surgical treatment group in T2D patients after at least 5 years of follow-up.

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Introduction

Type 2 diabetes is one of the fastest growing health problems worldwide [1]. Intensive pharmaceutical and lifestyle interventions typically result in a remission rate lower than 15% [2, 3]. Bariatric surgery, initially developed to treat severe obesity, might be a more effective treatment for type 2 diabetes [4]. Bariatric surgery results in sustained weight loss in obese patients with type 2 diabetes [5]. For some patients, such weight loss is accompanied by diabetes remission and improvement in cardiovascular (CVD) risk factors (i.e., hypertension, hyperlipidemia) [5, 6]. It has been estimated that type 2 diabetes can be resolved in 78% of the patients who undergo bariatric surgery [7]. The superiority of bariatric surgery over non-surgical therapy in inducing significant weight loss, diabetes remission, and improvement in CVD risk factors has been proven in randomized controlled trials (RCTs) [8–10]. However, most of these studies have limited follow-up time frames (≤ 2 years). Existing evidence to determine to which degree these short-term benefits sustain over time is insufficient.

Two meta-analyses have shown that bariatric surgery was associated with greater short-term (≤ 2 years) weight loss and better glucose outcomes as compared with medical treatment [11–13]. Two recent meta-analyses using studies that followed patients up to 5 years also indicated that type 2 diabetes patients receiving bariatric surgery had a significantly higher remission rates (relative risks (RRs) ranged from 5.7 to 76.4) [14, 15]. To our knowledge, there is no systematic review and meta-analysis synthesizing the effects of bariatric surgery on diabetes remission beyond 5 years post-surgery among patients with type 2 diabetes or of the impact on microvascular or macrovascular events, and death as compared with non-surgical treatments. The objective of this study was to systematically review and evaluate the available data comparing the remission rates, microcardiovascular and macrocardiovascular events, and mortality rates to non-surgical treatments in patients with type 2 diabetes.

Methods

Data Sources and Searches

Our systematic literature search was conducted in the National Library of Medicine (PubMed/MEDLINE), SpringerLink, and EMBASE databases to identify English articles published from January 1, 1990 to October 31, 2016, using the keywords of “bariatric surgery,” “metabolic surgery,” “diabetes surgery,” “gastric band,” “sleeve gastrectomy,” “gastric bypass,” “duodenal switch,” or “biliopancreatic diversion” linked to “type 2 diabetes,” “diabetes mellitus,” “medical treatment or therapy,” “conventional treatment/therapy,” “diabetes remission,” “diabetes complication,” “death,” or “mortality.” This search resulted in 1238 abstracts, which were further screened using the following inclusion criteria (Fig. 1).

Study Selection

We selected the original studies conducted with humans based on the following criteria: (1) RCT or cohort studies, (2) targeted on or had subgroup analysis in patients with T2D, (3) reported at least one of the four outcomes of interest (diabetes remission, incidence of diabetes microvascular complications, incidence of diabetes macrovascular complications, or mortality), and (4) patient follow-up for at least 5 years. If separate articles from the same study were published, the article with the most updated data was selected. In case of duplicate publications, only one publication was included. Among 1238 abstract identified, we excluded those not conducted with humans ($N = 80$) or not using original data (e.g., reviews, comments or letters to the editor, or meta-analysis) ($N = 581$). We reviewed 577 articles with full text. We also performed a manual searching of references cited in original studies and relevant review articles ($N = 40$). Among them, we excluded studies that (1) did not have a comparison group or case reports only ($N = 388$); (2) did not target on patients with type 2 diabetes ($N = 114$); (3) did not target on diabetes remission, microvascular complications, or macrovascular complications ($N = 74$); and (4) had study duration less than 5 years ($N = 27$). We also excluded two studies because they lacked quantitative measures of associations between surgery and outcomes and two articles because they were not based on the most recent data from the original study. Finally, we included 10 articles in the current systematic review.

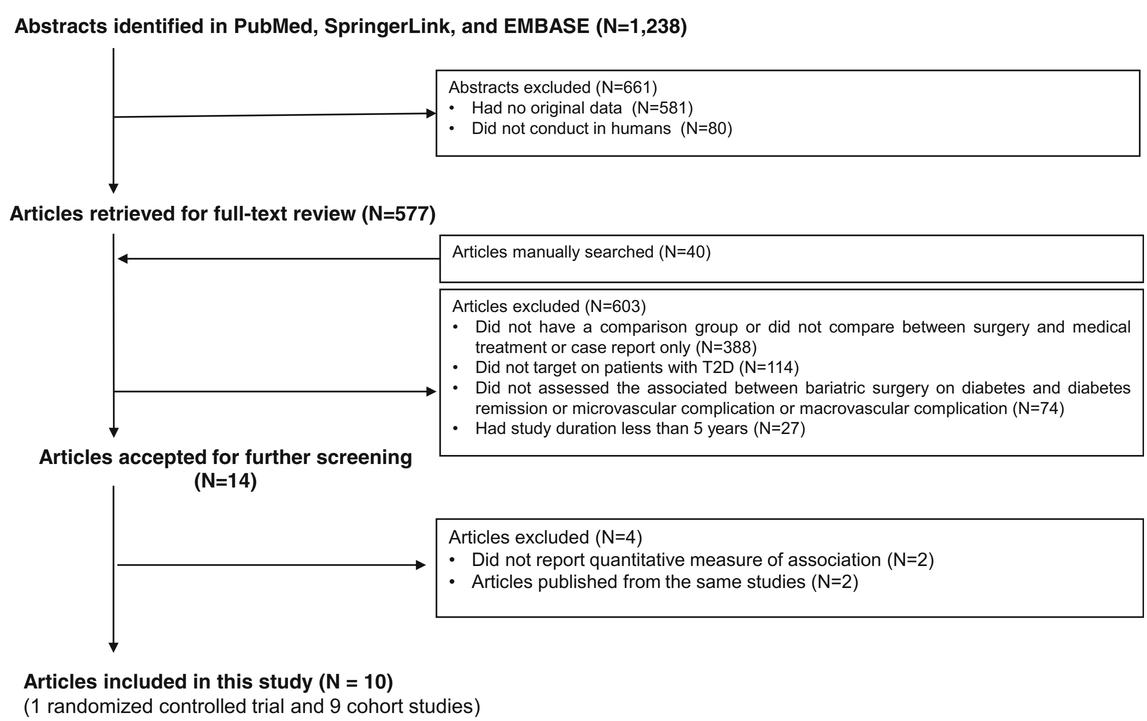

Fig. 1 Flow diagram of literature search

Data Extraction

Two authors (BS and XT) extracted the data independently using standardized data abstraction forms. Disagreements between reviewers were resolved by repeated examination of the original articles and by discussions within the team. We extracted information from original studies using the last name of the first author, year of publication, country of origin, patient body mass index (BMI) and age before the surgery, number of study participants, duration of follow-up, estimates of the association between treatment and outcomes (odds ratio (OR), RR, or hazard ratio (HR) and 95% confidence interval (CI)), and variables adjusted in the statistical analyses. Two additional authors (LC and LZ) reviewed all the extracted data from the original articles to check on information accuracy.

Data Synthesis and Analysis

We pooled results for the meta-analysis only if there was a minimum of three studies with the same research design and outcomes were equal or greater than three. We performed analyses for four different outcomes: (1) diabetes remission (cessation of glucose-lowering medications, or achievement of targeted glycated hemoglobin (HbA1c) thresholds) [16], (2) incidence of microvascular complications (e.g., diabetic nephropathy, neuropathy, or retinopathy), (3) incidence of macrovascular complications (e.g., angina, not-fatal myocardial infarction, stroke, revascularization of coronary, congestive heart failure, or lower extremity arteries) [17], and (4) all-cause mortality.

We assessed statistical heterogeneity using the DerSimonian and Laird's Q statistic and I^2 statistic ($I^2 > 50\%$ was considered as meaningful level of heterogeneity). We also conducted a sensitivity analysis in which each study was excluded, in turn, to evaluate the influence of that particular study on the overall estimates. We examined the publication bias using funnel plots and Begg's test. All statistical analyses were conducted with STATA 12.0 (Stata Corporation, College Station, TX).

Results

Study Characteristics

Table 1 provides a summary of the main characteristics of the 10 studies (1 RCT and 9 cohorts) included in this review. Their sample sizes ranged from 50 to 15,951 participants, and follow-up time ranged from 5 to 15 years. Among all studies, four were conducted in the USA [18–21], two in Sweden [17, 22], two in Italy [23, 24], one in UK [25], and one in China [26]. All studies included both men and women, with the average age close to 50 years. In all studies, the patients in the comparison group were given non-surgical treatments for type 2 diabetes (e.g., oral hypoglycemic medications and insulin). One study mentioned that patients in the comparison group were also given lifestyle coaching [19]. In the following sections, we referred to the comparison group as the "non-surgical treatment group." Among four US studies [18–21], all racial groups were included, but the majority of patient populations were white. With regard to the pre-operational BMI, six studies included only patients with BMI ≥ 35 kg/m^2 [17–19, 21, 23, 24], two studies included patients with BMI less than 35 kg/m^2 [22, 25], and one study included patients only with BMI ≤ 35 km/m^2 [26].

Meta-Analysis of Cohort Studies

Diabetes Remissions

A total of 3204 type 2 diabetes patients from six studies [17–19, 21, 25, 26] were included in this meta-analysis to compare the diabetes remission rates between the bariatric surgery and non-surgical treatment groups. Patients in the surgery group had a higher rate of diabetes remission as compared with those in the non-surgical treatment group (RR = 5.90; 95% CI = 3.75–9.27) (Fig. 2a). There was no significant heterogeneity across studies ($Q = 0.04$, $I^2 = 0\%$). The funnel plots and Egger's test suggested no publication bias ($P = 0.36$).

Microvascular Complications

A total of 16,762 type 2 diabetes patients from four studies [17, 19, 20, 23] were included in this meta-analysis to compare the microvascular complications between the bariatric surgery and non-surgical treatment groups. Patients in the surgery group had a lower incidence of microvascular events as compared with those in the non-surgical treatment group (RR = 0.37; 95% CI = 0.30–0.46) (Fig. 2b). There was significant heterogeneity across studies ($Q = 6.60$, $I^2 = 54.5\%$). The funnel plots and Egger's test suggested no publication bias ($P = 0.13$).

Macrovascular Complications

A total of 29,026 type 2 diabetes patients from five studies [17, 19, 20, 22, 23] were included in this meta-analysis to compare macrovascular complications between the bariatric surgery and non-surgical treatment groups. Patients in the surgery group had lower incidence of macrovascular events as compared with those in the non-surgical treatment group (RR = 0.52; 95% CI = 0.44–0.61) (Fig. 2c). There was significant heterogeneity across studies ($Q = 13.92$, $I^2 = 71.3\%$). The funnel plots and Egger's test suggested no publication bias ($P = 0.32$).

Table 1 Summary table of the included studies

Author, year	Study country	Study design	Surgery types	Outcomes	Follow-up (years)	Sample size	Race	BMI at baseline (kg/m²)	Age at baseline (years)	Adjusted covariates[a]
Randomized controlled trials (RCTs)										
Mingrone, 2015	Italy	RCT	RYGB, BPD	[1]/ [2]/[3]	5	60	NA	≥ 35	30–60 (all)	
Cohort studies										
Chen, 2016	USA	Retrospective	RYGB	[1, 2]/[3]	14	158	Mixed	49.9 (S); 45.9 (C)	45.8 (S); 48.8 (C)	BMI, age, sex, race, and severity of diabetes
Gulliford, 2016	UK	Retrospective	AGB, RYGB, SG	[1]	6	1652	NA	≥ 30 (all); 46.7 (S); 42.2 (C)	≥ 20 (all) 50.0 (S); 49.1 (C)	BMI, age, sex, diabetes duration, coronary heart disease, stroke, depression, smoking, total cholesterol, hypertension, use of antihyper tensive drugs and statins, and year of procedure
Eliasson, 2015	Sweden	Retrospective	RYGB	[3]/[4]	8	12,264	NA	All BMI 42.0 (S); 41.4 (C)	All age 48.5 (S); 50.5 (C)	BMI, age, sex, calendar time in the database, systolic and diastolic BP, LDL and HDL cholesterol, HbA1c, history of myocardial infarction, congestive heart failure, or stroke, smoking, use of antihypertensive, lipid-lowering, and glucose-lowering drugs, marital status, education level, and yearly income
Hsu, 2015	Taiwan, China	Retrospective	SG, RYGB	[1]/[4]	5	300	Chinese	< 35 (all) 24.8 (S); 29.1 (C)	18–67 (all) 57.5 (S); 51.2 (C)	BMI, age, and diabetes duration
Sjöström, 2014	Sweden	Prospective	AGB, NAGB, VBG, RYGB	[1]/[2]/[3]	15	603	NA	≥ 34 (M); ≥ 38 (F)	37–60 (all) 50.4 (S); 48.7 (C)	Age, sex, weight, height, waist and hip circum ferences, systolic BP, diastolic BP, serum cholesterol and triglyceride, smoking, menopausal status, four psychosocial variables (social support, life events, health perception, psychosocial functioning), two personality traits (monotony avoidance, and psychastenia)
Johnson, 2013	USA	Retrospective	RYGB, AGB, VBG, BPD, SG	[2]/[3]/[4]	14	15,951	Mixed	≥ 35	18–77 (all) 47.5 (S); 52.1 (C)	BMI, age, sex, hypertension, hyperlipidemia, smoking, sleep apnea, and insurance
Adams, 2012	USA	Prospective	RYGB	[1]	6	159	Mixed	≥ 35	18–72 (all)	BMI, age, sex, race, income, education, and marital status
Iaconelli, 2011	Italy	Prospective	BPD	[2]/[3]	10	50	NA	> 35 (all); 50.5 (S); 51.1 (C)	25–60 (all); 43.8 (S); 43.7 (C)	BMI, age, sex, serum cholesterol and triglyceride, and smoking
MacDonald, 1997	USA	Retrospective	RYGB	[1]/[4]	9	232	Mixed	199 lb more than the idea weight; 50.6 (S); 48.8 (C)	< 64 (all); 41.9 (S); 43.5 (C)	BMI, age, sex, and hypertension

Diabetes remission [1], microvascular complications [2], macrovascular complications [3], mortality [4]

RCT randomized controlled trial, *BMI* body mass index, *S* bariatric surgery group, *C* comparison group, *BP* blood pressure, *RYGB* Roux-en-Y gastric bypass, *AGB* adjustable gastric banding, *SG* sleeve gastrectomy, *NAGB* non-adjustable gastric banding, *VBG* vertical banded gastroplasty, *BPD* biliopancreatic diversion

[a] Either matched in selection of control group or adjusted in the statistical analysis models

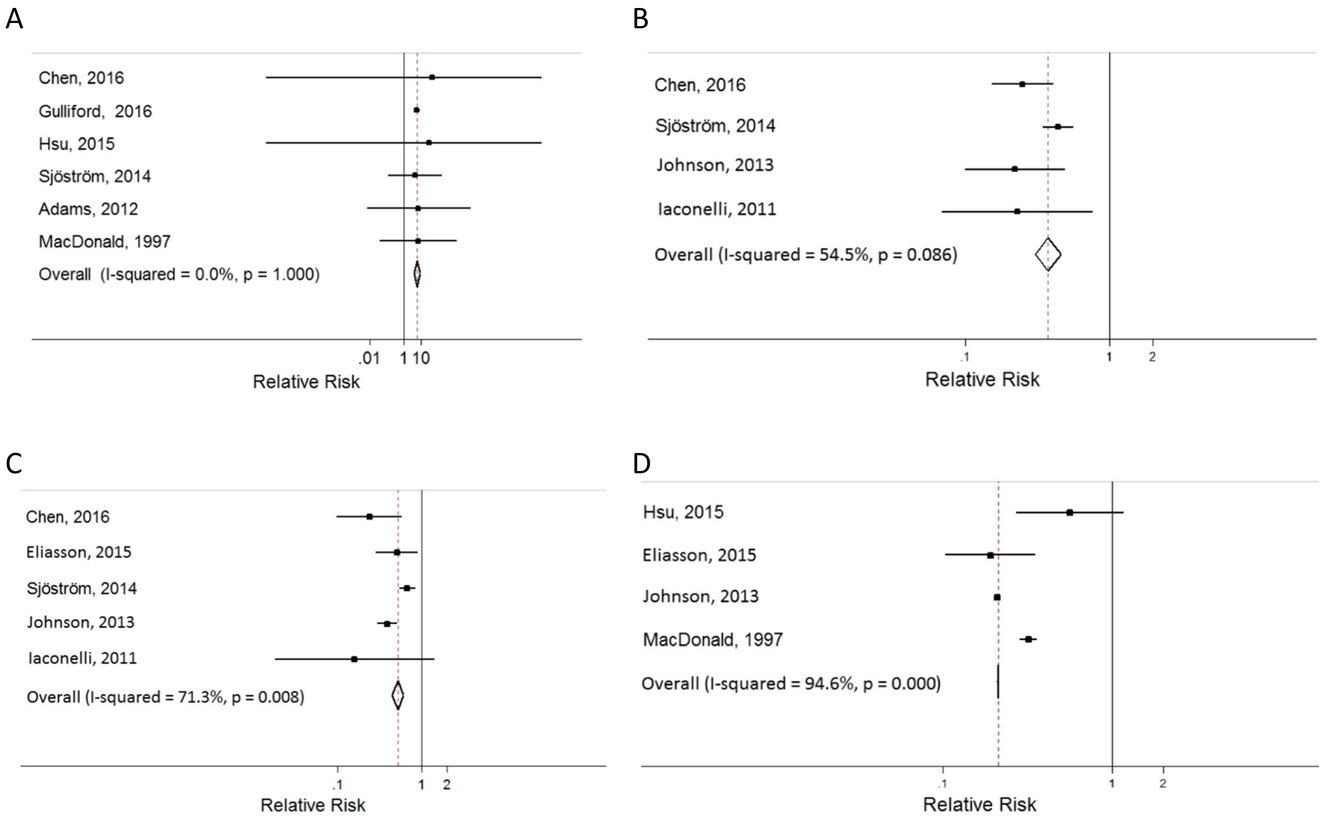

Fig. 2 Forest plots of comparing remission rates of type 2 diabetes (**a**), microvascular complications (**b**), macrovascular complications (**c**), and mortality (**d**) between bariatric surgery and conventional medical groups

Mortality

A total of 28,605 type 2 diabetes patients from four studies [20–22, 26] were included in this meta-analysis to compare the mortality rates between the bariatric surgery and non-surgical treatment groups. The bariatric surgery group had a lower mortality rate as compared with the non-surgical treatment group (random model, RR = 0.21; 95% CI = 0.209–0.213) (Fig. 2d). There was significant heterogeneity across studies ($Q = 55.85$, $I^2 = 94.6\%$). The funnel plots and Egger's test suggested no publication bias ($P = 0.30$).

Sensitivity Analyses

Sensitivity analysis was performed to assess the influence of each individual study on the pooled results by sequentially repeating the meta-analysis excluding one single cohort study from the analysis at a time. The results of the sensitivity analyses suggested that the pooled point estimates were not significantly affected by any single study (data not shown).

Evidence from a RCT

The only RCT study that followed patients after the surgery for 5 years was conducted in Italy [24]. In this RCT, 40 T2D patients were assigned to the surgery group and 20 were assigned in the non-surgical treatment group. Of them, 15 patients (75%) in the non-surgical treatment group and 38 (95%) in the surgical group were followed at year 5. At year 5, the diabetes remission rate was 50.0% (15 of 38) in the surgery group versus 0.0% (0 of 15) in the non-surgical treatment group. One (2.6%) microvascular event (nephropathy) was reported in the surgery group, and four (26.7%) events (one retinopathy, one nephropathy, and two neuropathy) were reported in the non-surgical treatment group (RR = 0.10; 95% CI = 0.01–0.95). The incidence of coronary heart disease was 0.0% in the surgery group and 7.0% in the non-surgical treatment group.

Discussion

Findings from our systematic review agree with the growing body of evidence that shows the superiority of bariatric surgery over non-surgical treatment in diabetes remission, as well as a significant reduction in the risk of microvascular and macrovascular diseases and mortality among type 2 diabetes patients who have had their surgery for more than 5 years. In the meta-analysis of cohort studies, we found that there was a significantly higher rate of diabetes remissions, lower incidence of microvascular and macrovascular diseases, and lower rate of death in the surgery group as compared to the non-surgical treatment group. These results were confirmed by one RCT study which followed the study participants for 5 years.

Diabetes Remission

Findings from our analysis were consistent with the results of several previous meta-analyses that compared bariatric surgery to medical treatment up to 5 years. For diabetes remission, a meta-analysis of studies that followed patients up to 24 months indicated that the remission rate ranged from 9.8 to 15.8 times higher in the surgical group as compared with conventional therapy (63.5 vs. 15.6%) [27]. In our meta-analysis of six cohort studies that following patients for at least 5 years (range 5–15 years), the diabetes remission was still approximately six times higher in the surgical group than in the medical treatment group, indicating that the superiority of bariatric surgery over medical therapy on diabetes remission can be maintained 5 years after surgery. A recent meta-analysis of eight RCTs that followed patients from 1 to 5 years also estimated that the pooled RR for diabetes remission was 5.76 (95% CI 3.15–10.55) for T2D patients in the bariatric surgery group as compared with the medical treatment group [15]. Another meta-analysis with six RCTs following patients up to 5 years but only including the estimated effect of Roux-en-Y gastric bypass (RYGB) found that the RR of diabetes remission among bariatric surgery patients was much higher (RR = 76.73; 95% CI 20.70–281.73) as compared to the non-surgical patients [28]. In this review, we identified only one RCT with follow-up time of 5 years [24]. According to this RCT, 82% of the surgical type 2 diabetes patients were able to maintain diabetes remission 5 years after the surgery.

Patients' baseline characteristics that positively predicted the diabetes remission after bariatric surgery include younger age, shorter duration of diabetes, better glucose control, and better β cell function [29]. Independent of these patients' characteristics, weight loss followed by the surgery has been shown as one of the most important mechanisms that help to achieve better diabetes control. Percentage of weight loss has been found to be positively associated with remission among type 2 diabetes patients who underwent bariatric surgery [30]. However, improvement of glycemic control was observed in the early post-operative period before significant weight loss occurred, indicating that additional mechanisms might exist. Other proposed mechanisms that explain the improvement of glycemic control in type 2 diabetes patients after bariatric surgery included changes in the secretion of gastrointestinal hormones (e.g., glucagon-like peptide-1 (GLP-1), glucose-dependent insulinotropic polypeptide (GIP), peptide YY, and growth hormone-releasing peptides), improved capacity for insulin secretion, and alterations in gut physiology and microbiota [31]. The gastrointestinal hormones play critical roles in the entero-insular axis in regulating insulin release within the intestine [32]. GIP activates GLP-1 [33, 34], and GLP acts on receptors located in pancreatic β cells, inhibiting glucagon secretion, thereby resulting in glucose-dependent insulin secretion [35]. The improved capacity for insulin secretion after bariatric surgery may also be associated with inhibition of apoptosis of β cells in pancreatic islets or tissue repair [36].

Microvascular and Macrovascular Diseases

To our knowledge, this is the first meta-analysis demonstrating that bariatric surgery significantly reduces microvascular and macrovascular events among type 2 diabetes patients as compared to patients receiving only non-surgical treatment: the estimated average reduction was 48% in macrovascular risk and 79% in microvascular risk in cohort studies with follow-up durations between 5 and 15 years. We only identified one RCT study that followed patients with type 2 diabetes for 5 years. Results from this RCT also showed approximately 90 and 97% decreases in microvascular and macrovascular disease risks in the surgery group than in the medical group, respectively. The greater improvement of glycemic control and other risk factors for the microvascular and macrovascular complications of type 2 diabetes may account for the reduced incidence of microvascular and macrovascular events observed in the surgery group. In addition, patients in the gastric bypass group showed higher plasma concentrations of high-density lipoprotein-cholesterol, suggesting that differences in gastrointestinal anatomy might also induce distinct effects on lipid metabolism [24]. We found significant heterogeneity across the studies included in the meta-analysis of the microvascular outcomes. One possible explanation is that we combined diabetic nephropathy, neuropathy, or retinopathy events all together, and indeed, there is substantial heterogeneity across these different microvascular outcomes. Unfortunately, studies included in this review and meta-analysis did not allow us to conduct additional analysis, stratified by type of these microvascular events. There are only four studies reported long-term microvascular outcomes, and none of them differentiated the type of microvascular events in their analyses. It is possible that bariatric surgery has varying impacts on diabetic nephropathy, neuropathy, or retinopathy. For example, diabetic retinopathy (DR) is the most common microvascular complication of diabetes. Although overall improvement in glycemic control has been associated with reduced development of DR in the long term, concerns have been raised about an initial worsening of the DR that may be related to a rapid decrease in blood glucose levels that occur after the bariatric surgery [37]. However, very few studies have compared the short-term DR outcomes between bariatric surgery and non-surgical treatment. One case-control study

[38] and a RCT study [39] have reported no difference in DR outcomes at 1 or 2 years after the surgery. Up to date, the effect of bariatric surgery on DR remains inconclusive.

Mortality

This study is also the first meta-analysis that compares mortality rates between bariatric surgery and non-surgical treatment groups among type 2 diabetes patients. Of the four cohort studies that reported mortality between bariatric surgery and comparison groups among patients with type 2 diabetes, the mortality rate was 79% lower in the surgery group as compared to the medical treatment group. Our results coincide with other studies that compared the mortality rate after bariatric surgery to medical treatment among general obese patients. A large retrospective cohort study in the USA with the maximum follow-up of 18 years (mean follow-up 7.1 years) reported a 40% lower mortality in the gastric bypass group as compared to the non-surgical treatment group in obese individuals [40]. In a meta-analysis conducted in 2014, which included 10 studies among obese patients, comparing bariatric surgery to non-surgical treatment, the estimated risk of death from the pooled analysis was 52% (OR = 0.48; 95% CI = 0.35–0.64) in the surgery group [41].

Consideration of Patients' Age, Sex, Race, Surgery Type, or Pre-Operational BMI

Given the nature of the data, it is not feasible for us to conduct stratified analyses based on patients' age, sex, race, surgery type, or pre-operational BMI due to the small number of selected studies or the lack of such data in the original studies. Most studies included in this review included type 2 diabetes patients with BMI $\geq$ 35 kg/m^2. In one study that targeted Chinese type 2 diabetes patients with BMI $\leq$ 35 kg/m^2, the surgery was associated with greater weight loss, a higher diabetes remission, and lower incidence of death [26]. This finding is consistent with the conclusion from two meta-analyses of relatively short-term studies ($\leq$2 years) in type 2 diabetes patients with BMI between 30 to 35 kg/m^2 [11, 42] and < 30 kg/m^2 [43], suggesting that type 2 diabetes patients with BMI lower than 35 kg/m^2 may also benefit from bariatric surgery. It has been suggested that younger patients may benefit more from bariatric surgery, but benefits do not differ by gender [29].

With regard to the surgery types, current evidence suggests a progressive relationship of diabetes remission and type of bariatric procedures: diabetes remission was found to be 48% for laparoscopic adjustable gastric banding, 84% for gastric bypass, and 98% for biliopancreatic diversion/duodenal switch after 2 years of the surgery [5]. A recent study also showed a 23% remission after gastric bypass and 29% after sleeve gastrectomy after 5 years of the surgery. However, a Swedish study did not observe significant differences in 10-year diabetes remission by surgery type [17]. Little is known whether CVD outcomes and morality rates vary by surgery types. There is limited long-term data following individuals who have undergone bariatric surgery and even more limited data for newer procedures such as sleeve gastrectomy and biliary pancreatic diversion (BPD) [44]. A number of alternative procedures to bariatric surgery, such as intragastric balloons, endobarriers [45], and anastomosis gastric bypass [46], have been evaluated in short-term studies, but not on CVD events and mortality. Available data do not yet permit meaningful conclusions on the comparative efficacy of different surgical procedures in patients with type 2 diabetes.

Strengths and Limitations

Although evidence from cohort and RCT studies have suggested greater benefits for patients with type 2 diabetes who underwent bariatric surgery as compared with non-surgical therapies, it is still debatable as to whether bariatric surgery should be the preferred treatment for type 2 diabetes due to the lack of long-term evidence. This review addressed this literature gap by summarizing and synthesizing the current available data on comparing diabetes remission rates, microvascular and macrovascular disease risks, and mortality rates between type 2 diabetes patients receiving bariatric surgery with longer than 5-year follow-up and those who are receiving non-surgical treatment alone. While long-term outcomes of bariatric surgery seem to be favorable, interpretation of these findings needs caution due to the inherent limitations of the reviewed studies. The first limitation is that the diagnostic criteria for diabetes remission and microvascular and macrovascular disease outcomes varied considerably across studies, thus potentially contributing to the heterogeneity detected in the current meta-analysis and in return making the comparison of results less compelling. The second limitation is that the majority of the reviewed studies are observational in design and thus are subject to selection biases. While all studies have controlled for important confounders in study design or/and data analyses, the residual confounding cannot be completely ruled out. The third limitation is that several studies have considerably low follow-up rates, which could affect the internal validity of these studies. Lastly, the intensity of care may be greater in patients who underwent surgery than those receiving the non-surgery treatment, resulting in possible over-estimated effect. Nevertheless, findings from this meta-analysis are supported by the similar results from previous meta-analyses of RCTs that followed patients for up to 5 years.

Conclusions

In conclusion, we identified 10 studies that followed patients from 5 to 15 years in patients with type 2 diabetes. The results of this review and meta-analysis suggests a better remission rate and a lower risk of macrovascular and microvascular disease and mortality in the surgery group as compared with surgical treatment group. Larger RCTs with high follow-up rates and data permitting the evaluation of different types of bariatric surgery are warranted to provide guidelines for treatment preferences for type 2 diabetes patients.

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Authors' Contribution All authors contributed to the development of study concepts; BS and XT extracted the data from the original articles; LC and LZ reviewed all the extracted data to check on information accuracy. BS and LC conducted the statistical analyses and drafted first version of the manuscript. All authors reviewed and edited on the manuscript.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval and Informed Consent This is a review article. For this type of study, formal consent is not required

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